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ON THE HABITS AND BEHAVIOR OF THE HERRING GULL, *LARUS ARGENTATUS* PONT. (*Concluded.*)

BY R. M. STRONG.

Plates XIX-XX.

VII. REACTIONS TO STIMULI.

1. *Auditory.*— I know of no experimental work on the reactions of gulls to sound stimuli, but I have made numerous observations in the field and with my captive gulls which show that hearing is reasonably keen in these birds, especially under certain circumstances. The bird shown in Plate VII, Fig. 2,¹ was easily startled during the earlier part of my tent studies by the small though sharp noises made by the shutters of my cameras. During the course of the day, this gull became less and less sensitive to such noises and to other slight sounds which came from my tent, though one end of the tent was hardly five feet away. The responses finally consisted of little more than short turns of the head. A pistol shot from a boat fully a quarter mile away from shore caused a wild panic on the island. Little attention had been given to the boat before the shot was fired and boats could come nearer without causing a disturbance so long as no shooting occurred.

On another occasion, the sharp noise made by a falling timber on the beach caused great alarm among gulls which could hardly have seen the fall. Great excitement was caused during the night of my stay on one of the Strawberry Islands by the noise produced by a falling board which was blown down from a position against my tent. It is improbable that many gulls if any could have seen this board fall. The resemblance of such noises to that made by the firing of a gun undoubtedly explains the intensity of the reactions. Many and perhaps all of the adult gulls had learned the significance of a gun shot.

My captive gulls when tested by some simple experiments on Sept. 27 and 29, 1913, were not much disturbed by any noises which

¹ See Auk, January, 1914.



1. GULLS FACING THE WIND IN A STORM.
2. YOUNG GULL, HALF GROWN BUT STILL IN DOWN PLUMAGE, PANTING.

I made out of their sight, though they responded to various sharp sounds or to a sudden shrill whistle by quick turns of the head.

2. *Visual reactions.*— Like practically almost all birds the Herring Gull is predominately visual in its behavior. It also appears to be unusually alert to visual stimuli. Rapid movements, especially, are noticed as is the case with most seeing animals, so far as we know anything of their reactions to visual stimuli.

Standing outside of my tent, I could distinguish the form of a man inside through the thin tent cloth, in certain positions with reference to the sun's rays. Small portions of the man's figure were also visible to me through narrow openings at the corners of the tent. It does not seem probable to me that the gulls could fail at least occasionally to get such glimpses for they often came within a few feet of the tent and it was evidently under constant scrutiny. Nevertheless, neither the gulls nor any other birds appeared to notice these evidences of the presence of a man inside. The visual images afforded under such circumstances were of course of very low light intensity and of vague outline. They were also very incomplete and often only small portions of a human form would be even faintly visible. At any rate they seemed to lack the intensity or completeness necessary for arousing the associations connected with the appearance of a man in the open.

On the other hand, I obtained some interesting evidences of sensitiveness to very small visual stimuli under other circumstances. In the course of my tent studies, I found a need for new openings before the series of apertures which appears in Plate IV, Fig. 1, had been prepared. A large pocket-knife blade was used for the purpose, and the cloth was cut cautiously. On two occasions the knife blade slipped through the cloth, unexpectedly, exposing a large portion of its length. These occurrences were the causes of small panics among a number of the gulls in the vicinity. The appearance of a small portion of my hand through one of the corner openings caused considerable excitement even when no rapid movements were involved.

I used my camera, however, at the openings with considerable freedom after the first hour or so of quiet watching inside the tent. The lens was often pushed partly through an opening without arousing any significant disturbance. It was a dark object and it

was moved slowly, whereas the shining steel of the knife blade came into view suddenly.

In spite of the failure of the gulls to be disturbed by possible glimpses of the man inside the tent, there is abundant evidence that these birds see unusually well, as compared with most birds, in weak light. As will be discussed in the section of this paper which deals with the nocturnal activities of gulls, these birds are often active at night. My captive gulls if very hungry will eat in considerable darkness when their food is placed in a customary position, even when it is not easy for me to make out more than the bare outlines of the pieces of food. Thus on May 3, 1913, I fed my gulls at about 8 P. M. The sky was clouded, and there was barely enough light to follow the movements of the birds from a position about fifteen feet away. The birds, which were thoroughly hungry, moved about somewhat uncertainly but they fed promptly from the two dishes in which their food was placed. When these birds were still partly in the nestling down plumage, on the evening of July 8, 1911, I made some notes on their movements at night. There was some light from the moon which was at half phase. I found the birds swimming or standing at the edge of the water in their enclosure, and they seemed to move easily in the semi-darkness.

During even the darker portion of the night that I spent on Middle Strawberry Island, I had plenty of auditory evidence that both adult and young gulls were more or less active when it was too dark for me to see anything of the birds. The moon set about 1:00 A. M., and there was no light except that furnished by the stars. Adult birds were evidently flying occasionally, and juvenals were occasionally heard peeping.

On many occasions, food has been brought to my captive gulls in paper wrappers. Often the package has been placed on the ground more or less completely open. When the paper is flapped by wind, the gulls show a good deal of apprehension. At one time they would not approach the package, although they could see that food was inside. They have become more accustomed to the flapping paper but have not entirely lost their fear of it. This experiment has been attempted only occasionally.

Even when there has been no flapping paper, great distrust has been shown for the package, when the contents were covered by

it though not entirely hidden. Under such circumstances, food is removed with slow and timid approaches followed by quick retreats. Flapping pieces of paper were for over a year very disturbing to the captive gulls, but after they had been fed daily for some weeks with food placed on a sheet of paper, their fear of moving paper decreased greatly.

3. *Reactions to Chemical Stimuli.*—During considerable portions of the time that I have had the captive gulls, I have conducted experiments on their reactions to chemical stimuli. A preliminary statement¹ concerning the results of this work has already been published, and I plan to publish another fuller account later. In general, I may say here that I have found my captive gulls showing what I interpret as a dislike for pieces of liver that had been dipped in solutions of table salt or in weak acids. The following notes are extracted from my records of the first experiment. On July 11, 1911, I placed a number of pieces of herring in a strong solution of table salt in a pan just before feeding the gulls. Another pan contained similar pieces of herring without any salt. The birds were very hungry not having been fed since the previous evening. All three birds showed great aversion for the salted fish. Two ate of the salted food at once and the other joined them in a moment. The response was immediate, one bird disgorging what it had swallowed. Another dropped what it had taken, and the third swallowed only one piece. All three birds ran to water in less than a minute and drank heartily, though they had taken very little of the solution. They did not return to the food during twenty minutes that I waited. Experiments with other materials were carried on after this until Sept. 6, 1911, when a 10% solution of sodium chloride was employed. Pieces of liver were placed in the solution. The birds were exceedingly hungry and ate voraciously paying no attention to the salt solution. On Sept. 23, a 20% solution of common table salt was tried with pieces of liver. The birds were not so hungry at this time. One went to the dish containing the salt solution and picked up a piece of liver with the tip of its beak. After a few minutes of cautious manipulation of the liver it was taken into the bird's mouth only to be hurriedly ejected. The gull

¹ Strong, R. M. 1912. The Sense of Taste in Birds. Science, N. S., Vol. XXXV, No. 911, June 14, p. 940.

at once jumped into the swimming tank and drank water, washing its beak vigorously. The other gulls did not take any food on this occasion while I was present. Later, similar reactions were obtained with weaker solutions of table salt and also with weak acids. Food was often rejected, even when the taste was just perceptible to me under the conditions of the experiments.

So far, I have almost no significant results with bitter and sweet solutions, although a great many tests have been attempted. This has been surprising to me as results were obtained readily with chicks and ducklings for the same solutions, with food, however, which would hold more of the solution.

The point of greatest interest to naturalists, perhaps, is the reaction to salt solutions, as it has long been a question to what extent sea birds drink sea water or tolerate it in their food. My gulls were fresh-water birds, of course, as they came from Green Bay, but field observations on salt-water gulls are in agreement with my experimental results, so far as they go.

Thus Anthony¹ states "That gulls drink sea water and can thrive on it is a fact not to be questioned, but I am of the opinion that when fresh water can be obtained without too much trouble they will drink it in preference. Several years ago I camped for a few days on the beach near a small fresh-water pond; during my stay sea gulls were constantly flying in from sea to drink, bathe, and preen their feathers. Many single birds were noted flying from as far as the eye could reach direct to the pond; after a few moments of rest and a drink, they returned to the sea in a manner that very plainly indicated that they had business there and had happened in merely to get a little fresh water." Several species of gulls were discussed in this article, including the Herring Gull, but, unfortunately, no single species is designated for the observations just quoted. Furthermore, Anthony does not give any evidence for his statement that gulls drink sea water. My own observations indicate that Herring Gulls, in cold weather, at least, do not need to drink often. They do not wander far from land relatively, and they are probably usually within a reasonable distance from fresh water.

Though fish and other meat that has begun to spoil are eaten to

¹ Anthony, A. W. Random Notes on Pacific Gulls. Auk, 1906, Vol. XXIII, No. 2, pp. 129-137.

some extent by very hungry gulls, fresh food is evidently preferred. My captive gulls never touch spoiled liver, for instance, if not very hungry, though fresh liver is taken promptly at such a time. Liver which has just begun to spoil, if eaten, is not taken with the same greediness, and a smaller quantity is swallowed. The first piece of tainted meat may be taken eagerly and sometimes partly swallowed only to be rejected. One or more pieces may be swallowed in haste if the birds are exceedingly hungry, before signs of disgust appear. Other pieces are handled with care on the same occasion, if touched at all. Bread which has been soaked in water that has contained such food as fresh raw liver, is eaten more eagerly than when plain water is used to moisten the bread.

It is a common practice of my captive gulls to carry some of their food to their swimming tank where they play with it in the water. A piece of liver is held in the beak and moved about under water with quick jerks of the head or it is dropped in the water to be seized before it has sunk far. This performance happens more frequently when the food has been lying in a chemical solution or when it has accumulated considerable dirt as a consequence of having been dragged on the ground. Such rinsing of the food does not occur at every feeding but is usual. The extent to which the food is thus treated also depends on the degree of hunger. When very hungry, food is bolted in a few seconds without much playing with it except sometimes for the last piece taken if hunger has been satisfied by the amount of food placed before the birds.

The behavior just described suggests some observations made by Anthony¹ with another species of gull. "I was one day watching some Western Gulls, a few yards from me on a wharf, when a large piece of salted fish was thrown out from an adjacent boat house. It fairly glistened with a thick incrustation of salt, and I was somewhat curious to see if the gulls would eat food so highly seasoned. No sooner had it fallen than it was seized upon by a gull and as quickly swallowed; but from the surprised actions of the bird it was evidently not to his liking; no sooner had it reached the stomach than it was ordered out again. Dropping the fish on the wharf, the bird eyed it for a moment. . . . Then picking up the fish it flew

¹ *op. cit.*, p. 135.

down to the water, and holding it under the surface shook its head from side to side violently 'sozzeling' the meat about for several seconds. It was then taken back to the wharf, laid down and inspected, and carefully sampled; this time, however, it was not bolted as at first but held for a moment in the mouth and rejected, and carried back to the water where it was even more roughly laundered. This operation was repeated several times and the piece of fish, which must have weighed four ounces at the outset, was reduced to half that size before it reached a state of freshness that suited the palate of the gull."

4. *Other Reactions.*—It is generally known that birds have a special development of nerves and endings of general sensation about the mouth with large trigeminal nerves for the sense organs involved. It is consequently reasonable to expect that my gulls when suspiciously manipulating food of uncertain palatableness employ their general sensation to a large extent. We do not know to how great an extent general sensation and the taste sense are used relatively by birds, but such information as is available indicates that the former plays the larger part. It has been shown by Botezat¹ for the birds which he studied that taste endings occur only in the back part of the mouth cavity and especially at the entrance to the gullet. In some birds they were also found at the base of the tongue, but they were never numerous.

On p. 181 of this paper, I described the behavior of one of my gulls when it started to eat liver which had been lying in solutions of table salt for a few moments. The piece of liver was manipulated in the front part of the mouth at the tip of the beak by the apparently suspicious bird. No avoiding reactions resulted and the food was often swallowed. Such a result suggests that the region of the mouth where tactile endings occur is first used in testing food. It is quite probable that the salt solution adhering to the piece of liver did not stimulate the tactile endings of the bird in the experiment and so was swallowed with a consequent strong stimulation of taste endings as the food slipped into the gullet. I have made similar observations on this behavior of my gulls when given uncertain food, on a number of occasions. It is not improbable that

¹ Botezat, E. Die Nervenendapparate in den Mundteilen der Vögel und die einheitliche Endigungsweise der peripheren Nerven bei den Wirbeltieren. *Zeitschr. f. wiss. Zool.* Bd. 84, 1906, s. 205-360.

mutual relations of stimuli exist between the tactile sense of the mouth region and either smell or taste or between all three. Readers who may be interested in the physiology of the beak region are referred to Edinger's¹ suggestions.

Gulls regularly show a positive reaction to strong air currents, that is, they face a heavy wind whether standing or swimming and usually when flying. This reaction is illustrated in Plate XIX, Fig. 1, where an adult and a number of juvenals are seen facing a heavy wind. Rain was falling when the picture was taken.

When the wind is exceptionally heavy, especially if rain is falling, gulls are commonly seen flying and they face the wind a large part of the time. During an exceedingly violent storm which occurred in the early afternoon of July 15, 1911, when I was on one of the Sister Islands, all of the gulls able to fly took to the air. Their flight manœuvres were similar to those which gulls so often show over a beach during a gale, at other times of the year. It is obviously more convenient to face a heavy wind as the bird's body is adapted to meeting air currents head on with little horizontal resistance.

Extremes of temperature apparently give gulls considerable distress. On a hot day, the brooding gull pants a great deal even when perfectly quiet on the nest.

Young gulls, especially if excited, pant constantly when the temperature is as high as 90° F. (see Plate XIX, Fig. 2). My captive gulls become very uncomfortable, apparently, and pant a great deal after taking only a few short flights of several yards each in their enclosure on a hot day. At such times they seek water and, if undisturbed, indulge in much bathing.

In zero weather (Fahrenheit) my captive gulls though well fed and fat appear to suffer from cold, especially after eating cold food. If the ground is covered with snow or ice in zero weather, the gulls squat upon their feet, apparently to keep them protected by their plumage. They rarely stand up at such times except when disturbed or to obtain food. They also show their sensitive-

¹ Edinger, L. The relations of comparative anatomy to comparative psychology. Jour. Comp. Neur. and Psych., Vol. 18, 1908, No. 5, pp. 437-457.

Also see Vorlesungen über den Bau der nervösen Zentralorgane des Menschen und der Tiere. Bd. 2. Aufl. 7, 1908 (or a still later edition). Leipzig, F. C. W. Vogel.

ness to cold by shivering although probably in perfect health. Wild gulls with abundant opportunities for flying apparently keep warm by being active, and I have not seen them showing such distress from cold.

VIII. SPECIAL ACTIVITIES.

1. *Flight*.—The great power in flight and especially the wonderful soaring performances of the Herring Gull are almost too well known to be discussed here. The wing strokes are relatively slow and the arc covered by the elbow is not large as is characteristic of birds with long wings.

I have witnessed on several occasions both on the Atlantic Ocean and on the Great Lakes the peculiar ability of the Herring Gull to follow or accompany a ship in the face of a strong head wind by soaring flight only, as described so well by Brewster.¹

It is a matter of common observation that gulls indulge in soaring manœuvres over a beach when a heavy wind is blowing off the water. At such a time they may often be seen soaring sidewise as well as forwards. I have seen Herring Gulls cover more than 200 yards in a single rapid sail sidewise along the beach, always facing the wind and not losing altitude. The Herring Gull is unusually skilful among gulls in soaring, and some of its feats are, to my mind, the most difficult to explain of all soaring phenomena.

The manner in which the feet are carried has been discussed by Anthony.² When starting flight the feet hang downward, sometimes until the bird is a number of yards from the starting place, and they are dropped just before alighting.

2. *Bathing and Drinking*.—References have already been made in this paper to the frequency with which Herring Gulls bathe in warm weather. My captive gulls enjoy swimming and bathing in their tank, even in winter, so long as the temperature of the air is not very much below freezing. When swimming the Herring Gull sits high on the water, probably in part because of the large amount of air contained in the dense ventral plumage. Possibly

¹ Brewster, W. Notes on the Flight of Gulls. Auk, 1912, Vol. XXIX, No. 1, pp. 85-92.

² op cit., p. 132.

this extreme buoyancy which also involves a large pneumatisation of the skeleton, explains the fact that gulls do not often dive to the extent of completely immersing their bodies.

When bathing, the Herring Gull dips its bill and often the entire head into the water with rapid bowing movements. At the same time the wings are flapped vigorously and water is splashed over the entire body. The performance is more or less the same whether the bird is floating on water or standing in shallow water.

During the colder weather of the winter, my captive gulls are deprived of all opportunities for bathing, as their tank is emptied. They become very dirty, consequently, in a city like Chicago. With the coming of spring, the tank is refilled and a regular orgy of bathing follows. Each bath lasts for several minutes and is followed by feather dressing and partial drying of the plumage. Then another bath is taken. This may continue for an hour or more. In the course of two or three days the plumage becomes quite clean.

On July 29, 1911, I found a young Herring Gull at one of the Strawberry Islands in well developed plumage and apparently old enough to fly. It was sitting quietly on the ground at the base of a tree at least fifty feet from water. On examination, I found the bird to be very much emaciated; it was too weak to make effective efforts to escape, in fact it could not stand upright. I took the gull to the water and gave it a chance to drink. It was evidently very thirsty, and drank eagerly. After taking what water it wished, the bird took a bath going through such movements as its limited strength and my grasp would allow. During the following week, I gave this bird frequent opportunities to bathe always holding it in my hands, and the bath was always taken without hesitation. The principal features were a plunging of the head under water with a quick removal, followed by a shake of the head which splashed water over the body. This bird ate ravenously but it was too weak to stand up for any length of time, and died in about two weeks. An autopsy was performed by a pathologist who was unable to find any other explanation for its death than the starvation the bird had experienced before I found it.

During the bathing performance the gull appears to drink more or less water, but it is difficult to say how much is taken. In hot weather there appears to be considerable water drinking by brood-

ing birds. The gull which appears in Plate VII, Fig. 2,¹ was studied carefully from my tent for several hours on June 26 which was a very warm day. During the middle of the day this bird made trips to the beach edge for water so frequently that I timed some of the periods. I found that the intervals between drinks varied from three to ten minutes. There was more or less bathing each time the bird went to water. I did not note any water drinking by gulls not brooding, at the breeding place.

My captive gulls seem to need very little water to drink in cold weather. During the first winter it was my practice to take warm water to the gull yard which would not freeze over immediately. In the winter of 1911-12, the temperature was below 0° F. for some weeks and during quite a portion of this time there was neither snow nor ice in the place occupied by the gulls. No other opportunities were present for the gulls to secure water than in their food or in the very slight amount of water which adhered to the food, mostly liver. I never saw any evidence of interest in the water which I brought to the gulls, and they seemed to thrive without it.

3. *Perching*.—The Herring Gull being a web-footed bird would not be expected to have a perching habit, nevertheless it does perch sometimes, after a fashion. One of my captive gulls may be seen in Plate XX perched on the side of the swimming tank, a position not infrequently assumed by these birds on leaving the water. On July 29, I saw Herring Gulls perched in the foliage of the upper outermost branches of tall trees on one of the Strawberry Islands. They did not remain there long and they presented the appearance of standing on foliage rather than on single limbs.

Other observers have reported seeing Herring Gulls perched in trees. Thus Clarke² saw these birds perching in pine trees while their nests were being photographed. Fleming³ noted Herring Gulls roosting on some dead pines at night. Of course there is no such gripping of the perch by the feet of a gull as is done by a true perching bird.

¹ See Auk, January, 1914.

² Clarke, C. K. Ontario Notes. Auk, 1901, Vol. XVIII, No. 4, p. 401-2.

³ Fleming, J. H. Birds of Parry Sound and Muskoka. Auk, 1901, Vol. XVIII, No. 1, p. 34.



HERRING GULLS IN JUVENAL PLUMAGE. ONE BIRD PERCHING AND ANOTHER SWIMMING.

IX. COMPARISON OF DIURNAL AND NOCTURNAL BEHAVIOR.

As Herrick¹ has well said, there is no repose by day or night in a gull colony. Adults take naps at all hours, either while on the nest or standing near. Often they simply doze with the head drawn close to the body and the eyes shut, or the bill may be tucked inside a wing with the eyes either open or closed in view. During the day groups of gulls stand about dozing as may be seen in Plate X, Fig. 2.

In order to get an idea of the entire daily cycle of activities at a gull breeding place, I spent a night at one of the Strawberry Islands. I arranged my trip so that it would cover those hours not included on other days. Ward also spent a night at a gull colony and I quote his interesting account² of his experiences as follows: "Sleep seemed to occur perhaps a little more frequently during the warmer hours of the afternoon than at other times, though pretty evenly distributed through the twenty-four hours. The birds sometimes stood, but more frequently squatted on the ground and turned their heads over their backs and tucked them under their wing feathers. Sleep was of very short duration, as fights, panics and alarms of various sorts followed one another too closely to allow of unbroken repose for more than a few minutes at a time. The night that I spent among them there was less sleep than during the day. The sun set about half past seven; but at eight o'clock the colony was as busy as ever fighting, making abortive nests and screaming. At ten minutes past eight the moon arose, and ten minutes later nearly all the gulls suddenly took wing in what I conceived to be a panic, until shortly afterwards I spied a large flock of them on the water in the direction of the moon. Later they worked around the island, so that I was between them and the moon, and I could then see that they were busily fishing. My notes continue up to a quarter of three, when I fell asleep with the gulls still on the water and noisy. When I awoke at twenty minutes after four the sun was up, most of the gulls were on the island and many young were teasing a few adults for breakfast."

On July 7, 1911, at 7:20 in the evening, I was on the island and

¹Herrick, F. H. *The Home Life of Wild Birds*. Revised Ed. 1905. Putnam's Sons, New York and London. p. 112.

²Ward, H. L. *Notes of the Herring Gull and the Caspian Tern*. Bull. Wisconsin Nat. Hist. Soc., Vol. IV., No. 4, October, 1906, p. 132.

I left the next morning at 7:05. My blind was erected, and I was inside ready for work at 7:45 when my companion left the tent and went away in the motor boat that had brought us. Within ten minutes, the gulls had settled down to normal activities, i. e. when the boat had gone a fair distance from shore. The "challenge" and mewing cries were made a number of times during the following half hour. I also heard the quack of a Red-breasted Merganser occasionally during this period, and a Bronzed Grackle flew near the tent. At 8:25 a Spotted Sandpiper call was heard, also a very young gull apparently calling for food. By 8:40 it was too dark to see my writing, and the gulls were quieter. There was an outbreak of noise, however, at 8:43 which lasted for a minute or so. I used a small pocket electric flash light, carefully concealed during the night, to see my watch and to make notes.

About 9:30 when the sunset glow was practically gone, a board was knocked down from one end of my tent, making a noise which alarmed the whole colony, and no birds came near my tent except in flight, so far as I could determine, until daybreak. The moon set about 1:00 A. M., and there was only starlight. I could not see any birds but I could hear them flying about all night giving the alarm cry, at intervals. The gulls were less noisy from 1:00 to 2:45. Small juvenals were heard calling occasionally through the night.

Shortly before 3:00 the first glow of approaching day appeared in the east, and the gulls began to settle down near my tent. They also became very noisy especially with the challenge cry. At this time I noted a female Red-breasted Merganser playing in the water not many feet away. Song Sparrows were singing, and Bronzed Grackles were active. A few minutes later a very small juvenal gull ran to the edge of my tent some fifty feet from where I first saw it. It passed within five feet of two adults who gave it no attention. The sun rose about 4:20, and at 4:25 two adult gulls came within three feet of my tent where they remained about a minute. They then flew away a short distance and returned to a point about ten feet distant. No birds were seen on nests, as the incubation season was over on this island.

At 4:40, I noted gulls bathing, and at 5:00 I saw a very small juvenal paddling ashore. A fight occurred between two adults

which was broken up by the interference of a third adult. About the same time I saw an attack on a juvenal gull by an adult resented by another adult. Challenge cries and mewing calls made a great noise at this time. Other juvenals which had been standing near the place where the attack was made disappeared.

A few moments later, I saw three gulls worrying a Great Blue Heron in full flight, much as kingbirds harass a crow. The heron finally disappeared in the woods on the largest of the Strawberry Islands where a heronry was located and from which I had heard noises throughout the night.

Another fight between adults occurred at 5:15, and as usual with no apparent injury to the participants. When the contest was over, the two birds faced each other and made a feint at renewing hostilities. Then they went through the challenge performance simultaneously.

At 5:25, I noted that I had seen no feeding and that most of the juvenals gave no evidence of desiring their parents, but at 5:45 I saw a downy juvenal teasing an adult for food and a feeding occurred a few minutes later. After the feeding, both birds drank water, and the adult swam out from shore about twenty feet where it took a bath. I noted at 6:25 that downy juvenals were standing idly most of the time or dressing their plumage. An adult approached a juvenal, and another adult flew to the spot, apparently to drive the first adult away.

I was unable to determine what the gulls were doing during the darker part of the night after the setting of the moon, beyond the flying already mentioned. Judging from the sounds, many of them were on the water as was the case during Ward's night at Gravel Island. Whether the falling of the board had anything to do with the absence of the gulls from at least my part of the island is uncertain. As the birds left Gravel Island at nearly the same time in the evening according to Ward's observations, there is some reason to believe that the board accident was not responsible. It is conceivable that there was some fear of the tent in the darkness which did not exist in daylight. Or possibly, the birds feel safer on the water at night and are in the habit of remaining there in a flock during a major portion of the night, when uneasy.

During the night of July 5 and 6, 1907, I camped on Partridge

Island in Lake Superior, about one mile from Gull Island, where a colony of gulls were breeding. In the latter part of the night just before dawn, I heard the cries of gulls flying overhead. The night had been very dark as the sky was clouded.

Some observations on the nocturnal activities of Herring Gulls have been reported by Schuster.¹ He noted these birds feeding on the river Mersey at Liverpool. Large quantities of food, thrown into the river at night from ships, are stated to be responsible for this nocturnal feeding. The gulls are described as flying and feeding silently.

Various writers speak of gulls "roosting" at night, and my captive gulls apparently sleep during the night, as a rule. It seems probable that gulls usually rest during the night, except during the breeding season or when food is especially available at night. It is also probable that gulls are not active when the darkness is intense.

X. VARIABILITY AND MODIFIABILITY IN BEHAVIOR.

According to Herrick² whose conclusions are in general supported by my own observations: "The life of birds is one of instinct irradiated by gleams of intelligence. Their mental faculties exhibit a wide range of gradation from excessive stupidity to a fair degree of intelligence with strong associative powers of things with ideas."

In my study of the Herring Gull, I have been especially interested in attempts at determining the extent of the "gleams," a fascinating but very elusive topic. The resourcefulness which animals show in new situations and the extent to which their behavior may be modified by new conditions may be considered fair criteria of their intelligence. Variability in behavior, however, has some bearing on the problem of intelligence. We must recognize perhaps two types of variability in behavior which do not indicate intelligence as it is commonly understood. They may even tend towards confusion in our analyses of behavior, as acts which may seem to

¹ Schuster, W. Möwen als Nachtvögel. Zool. Beob. Frankfurt a. M. Jahrg. 47, No. 3, S. 79, 1906.

² The Home Life of Wild Birds. Revised Ed. 1905. G. P. Putnam's Sons, p. 212.

indicate resourcefulness or adaptiveness may be only variations in stereotyped behavior.

It is to be expected that so-called pure lines or strains may be found among the behavior characteristics of a species as well as in other characters. Some of these strains may possibly be the result of or be accentuated by such segregation as is afforded by separate breeding places. Unfortunately we know nothing concerning the relationships of individuals in one colony to those of another. We have no information concerning whether gulls breeding at one of the Strawberry Islands, for instance, have interbred in recent years with Gravel Island gulls. Furthermore, we have no data as yet, concerning the existence of definable pure lines in the morphological characters of Herring Gulls.

The other type of variability in behavior is not associated with pure line inheritance. It represents simple chance variations from the average type of behavior which are to be expected just as we find variations in morphological characters.

In the section of this paper which deals with the general behavior of juvenal gulls, I mentioned variability in the behavior of some newly hatched gulls. A single bird in one nest showed no terror, whereas two nestlings of essentially the same age in another nest were in great distress from fright over the presence of human intruders. I can think of no reason for considering that either the quiet bird or the frantic pair were more intelligent or that either form of behavior was adaptive. Nor have we reason to believe that it was a case of pure line differentiation. It seems quite possible that chance variations in the metabolic states of the birds or possibly in their nervous organization were responsible for the difference in reaction to our presence. It is conceivable that the reactions would have been either similar or reversed if we had approached the nests a few hours later.

A large amount of variation has been noted in the choice of materials used in constructing the nest. Evidently the Herring Gull uses what is available with a preference for finer and softer materials. It seems probable to me that such nest building, which is evidently mostly instinctive or stereotyped, is not absolutely without the elements of intelligence. There must be adaptation of special materials which may be found, to use and location.

Though the general form, size, and location of the nest are characters of the species, the variations which fit the nest to its special location, for instance, are no more stereotyped than various acts of man which are called intelligent.

As a consequence of persistent nest robbing, gulls at certain breeding places have been reported as taking on a tree nesting habit. I know of no evidence worth considering for believing that the recent ancestors of such birds were tree nesters, and we have every reason for considering the inherited choice of location for most Herring Gulls as on the ground.

We have already seen in this paper that even the structure of the nest may be modified in adaptation to the location in a tree. More skill is shown in weaving the nest, according to reports, so that it will hold together in its tree location. Of course it may be said that tree nesting by the Herring Gull may be due to a so-called latent instinct which appears when persecution compels the bird to seek a safer place for its nests. We have however, no reason to believe that instinct behaves in inheritance differently than other characters. Our knowledge of the laws of inheritance does not furnish any basis for thinking that an instinct for tree nesting can exist for long periods of time in a species that has another habit, without itself appearing.

Herrick¹ seems to consider tree nesting for the Herring Gull to be a variation without much significance. He found a small percentage of gulls nesting in trees at a height of from six to ten feet. In his judgment, this position affords no protection to the birds. I have seen no nests above the ground though trees and bushes cover most of the ground on all but two of the islands where I have seen gulls breeding.

To me such tree nesting as Audubon² described suggests real resourcefulness, but we know too little about it to be warranted in making any generalizations concerning the intelligence it may involve. In some colonies tree nesting may possibly be the inherited habit or instinct of certain strains or "pure lines" of Herring Gulls.

The nestling offspring of tree nesting gulls are reported as re-

¹ Herrick, F. H. *Nests and Nest Building in Birds. Part II.* Journ. Animal Behavior. July-August, 1911. Vol. I, No. 4, pp. 244-277.

² Audubon, J. J. *Ornithological Biography.* Edinburgh. 1835. Vol. III, pp. 588-589.

maining in the nest when observed, though gulls of the same age on the ground would never be found in the nest but would always be hiding. That tree nesting juvenals do not leave their nest until they are able to do so without injury, is probably due to a realization of the danger involved in such an attempt. This remaining in the nest under such circumstances may possibly be regarded as intelligent behavior of perhaps a low order which prevails over any blind instinct to leave the nest to hide when intruders appear. Just how much this behavior is tied up with instinctive activity is of course beyond our knowledge.

The promiscuous feeding of juvenal gulls at Gravel Island appeared to me to be a variation from the probably usual habit of parents feeding their own offspring. Unfortunately we lack data for establishing the extent of this variation. It could easily be the consequence of the congested life on the island. I have noticed that juvenal Wilson's Terns seek food of any adult that may happen to come near them with food in its beak, but all of my observations indicate that the parent tern probably feeds only its own offspring. The gull must go through the somewhat complicated process of regurgitation which seems far from voluntary. Large numbers of juvenal gulls crowding about an adult who perhaps sees its own offspring in the mob may be able to snatch the food regurgitated without regard to parental relationships.

A large number of so-called lower birds like ducks, coots, etc. and the various species of gulls learn rather rapidly where they may feed and breed without molestation by man. In the course of only a week, wild ducks become far less shy on bodies of water in or about cities than when they arrive, a matter of common observation. Gulls likewise recognize even more positively that they are relatively safe in such places, but they are exceedingly wary wherever shooting occurs. Such discrimination undoubtedly involves at least the rudiments of intelligence even though the activities in question may be largely instinctive.

I had hoped to carry on some experiments on modifiability in behavior with gulls, but my time was taken up so largely with the general observations which I thought should come first that only a single experiment was started. An entire nest was moved four feet to one side at a distance of about one hundred feet from my

tent. The nest was under observation for several hours, and what appeared to be the owners were seen standing about the spot where the nests had been located. Though the birds seemed to be disturbed, they did not make any significant demonstrations of excitement, and they did not attempt to brood the eggs. Such an experiment should be started earlier in the season.

XI. MIGRATIONS.

After the breeding season is over, there seems to be a general movement southward. Thus on and after August 25, 1913, for instance, I saw a number of Herring Gulls, including both adults and juvenals, at Woods Hole, Massachusetts. I do not know how much earlier they may have been in the vicinity. Each day that I saw them they were in flocks with Laughing Gull adults and juvenals. So far as I know, Herring Gulls do not now breed south of Maine on the Atlantic coast. These birds had probably migrated from a point at least as far north as Maine.

"Gull Dick" as reported by Mackay¹ was in the habit of returning year after year to the region of the Brenton Reef Light ship in Narragansett Bay during early October. This bird left for the north in early April. In a report to Dutcher and Baily² it was stated that about 800 Herring Gulls arrived at Great Duck Island off the coast of Maine on March 12, and their numbers increased steadily until the 20th of May. Herring Gull adults and juvenals appear about Chicago in considerable numbers during the winter, and they are fairly common during a large part of April. The spring migration and the beginning of the breeding season apparently occur considerably later on Lake Michigan than on the Atlantic coast, a fact probably connected with the late clearing of the ice on the upper Great Lakes.

On September 21, 1911, my captive gulls, then juvenals, became very restless, and they ate very little food for seven days. On the 24th, I spent half an hour in my gull yard. The food that I had placed there on the previous day had not been eaten, and the gulls

¹ Auk, IX, 1892, pp. 226-228.

² Auk, XX, 1903, pp. 417-431.

paid no attention to the fresh supply I left. They were very restless and they were almost constantly flying about their quarters, often rising to the top of the enclosure, the most unusual feature of their activities. They went to the swimming tank which appears in Plate XX, frequently, though one of them prevented the others from spending much time on the water by driving them away. The gulls alighted frequently on the edge of the tank as shown in Plate XX, and they often remained there two or three minutes except when the belligerent gull drove the others away.

I have never seen so much activity by these birds as at that time except possibly on two or three other occasions which were also at the time of gull migrations. Unfortunately, it has not been practicable for me to watch the birds carefully during periods when migrations occur. The performances just described suggested to me the possible existence of a migration impulse as the cause. This suspicion is strengthened by the observations of others on the behavior of other captive wild birds at migration times, but it must be admitted that my notes on these performances of my gulls have only suggestive value.

SUMMARY.¹

1. The Herring Gull is gregarious in habit, but it is also quarrelsome. Some of the fights are undoubtedly the consequence of invasions upon nesting precincts as stated by Herrick, but many are probably due to simple belligerency. This bird is often a great coward and may be routed by smaller birds, the crow for instance. The fights between adults have always been harmless, in my experience. Herring Gulls will fight fiercely for food when very hungry.

2. Herrick's conclusion that the frequent killing of the young by adults is the consequence of the instinct to guard a nesting precinct probably holds true in many cases. There is, however, some evidence that this is not always the explanation. Juvenals sometimes attack younger birds just as savagely as the adults do and in the same manner.

3. Other birds often nest safely even on a small island densely populated by breeding gulls.

¹ This section is not complete. It includes principally the more important conclusions of this paper.

4. The Herring Gull nests usually in places the most inaccessible to man that are available. The breeding place is usually on an island not inhabited by man. When seeking food or aside from the breeding season, this bird is frequently to be seen near human habitations on the coast or following vessels.

5. This gull is practically omnivorous in its habits according to the observations of various writers. Animal food is preferred, but other food may be eaten if the bird is hungry enough.

6. The Herring Gull does not dive for its food to any extent, and it never plunges vertically into the water as Terns do.

7. Breeding begins later in Green Bay and on Lake Michigan than at points on the Atlantic coast much farther north. This difference is very likely due to the accumulation of ice in the northern portions of the Great Lakes, which does not disappear until after the beginning of spring.

8. The nests are made of such material as is available, but fine materials are preferred.

9. The offspring are shaded by the parents on a hot day until they are strong enough to leave their nest and seek a shaded spot.

10. The young are given food which is first regurgitated upon the ground. There may be promiscuous feeding of young birds by adults not their parents.

11. Young Herring Gulls not yet old enough to fly usually hide when human intruders appear as is the case with other members of the order. Sometimes only the head may be hidden but the bird sits perfectly still. If removed from its hiding place, the hiding instinct is replaced by the instinct to run away. The juvenals able to fly join the adults at such a time, in the general panic, overhead, or they fly away some distance, usually to water.

12. Herring Gulls which I have had in my possession since they were in the nestling-down plumage were less mature in plumage at two years than is indicated by Dwight for birds of that age. It is my judgment that Herring Gulls rarely breed before they are three years old. All of the breeding Herring Gulls which I have seen were adults, so far as I could determine.

13. It has been my experience that the young are at least two months old before they begin to fly well.

14. I have given especial attention to the voice of the Herring

Gull. The most frequent sounds are the "challenge" and the "alarm" cry. A "mewing" sound is fairly common. These cries all involve characteristic positions, especially the "challenge" and "mew." The "challenge" seems to represent a variety of emotional states but, in general, excitement. The young have a characteristic squeal or chatter which is high pitched. It is used in calling for food or with a little modification when frightened. My captive gulls began to use what appeared to be a rudimentary "challenge" cry in September of their first year. I have heard this only a few times.

15. Both vision and hearing are keen in the Herring Gull, as appears to be the case with most birds.

16. It has been my experience that the Herring Gull has nearly as good darkness vision as man at least. During the breeding season or when food is best obtained at night, this bird is very active at night. My captive gulls will eat, if very hungry, when there is barely light enough for me to distinguish their food.

17. Food which is wet with solutions of either table salt or acids is rejected. My birds detect the presence of these solutions even when they are very weak to my taste.

18. Meat is eaten much more readily when it is fresh. The extent to which spoiled meat is tolerated varies directly with the degree of hunger.

19. It is a common practice of these birds to rinse food of uncertain palatableness or when it is dirty, in water.

20. Some evidence was obtained concerning the use of nerves of general sensation in testing food.

21. A positive reaction is shown to air currents. In a severe storm, gulls leave the ground and indulge in flight manoeuvres.

22. The Herring Gull is sensitive to extremes in temperature. In very cold weather, the feet are kept protected by the plumage a large portion of the time.

23. There is a large amount of bathing, especially in hot weather. In very cold weather, no water seems to be required beyond that present in the food obtained.